# COMPARISION OF ANTIMICROBIAL ALTERNATIVES IN IRRADIATED DIETS FOR NURSERY PIGS

*T.P. Keegan, J.M. DeRouchey, J.L Nelssen, M.D. Tokach, R.D. Goodband, S.S. Dritz[1], and C.W. Hasted*

## Summary

Previous research at Kansas State University indicated that irradiation can effectively reduce the bacteria concentration in nursery diets. Therefore, we hypothesized that eliminating bacteria in the feed via irradiation would provide a model to determine the effectiveness of antimicrobial alternatives. In a 27-d growth assay, 330 weanling pigs (13.2 lb and 18 ± 2 d of age, PIC) were fed one of 9 experimental diets: 1) control diet with no antimicrobials, 2) irradiated control diet with no antimicrobials, and the irradiated control diet with added: 3) carbadox (50 g/ton), 4) Probios® (1.6% from d 0 to 14 and 0.8% from d 14 to 21), 5) BioSaf® (0.3%), 6) Biomate Yeast Plus® (0.1%), 7) Bio-Mos™ (0.3%), 8) Bio-Plus® 2B (0.05%), or 9) LactoSacc® (0.2%). BioSaf®, Biomate Yeast Plus®, and Lacto Sacc® are all concentrated forms of selected live yeast cells while Bio-Mos™ is a mannanoligosaccharide derived from yeast. Probios® is a form of lactic acid bacteria and Bio Plus® 2B contains two bacillus strains. All antimicrobials were added after diets were irradiated.

Neither irradiation nor feed additives in an irradiated diet improved growth performance compared to the nonirradiated control. Pigs fed the diet containing Probios had poorer ($P<0.05$) F/G compared to all other test diets except pigs fed the diet containing BioSaf. Pigs fed both the non-irradiated and irradiated control diets and Bio Plus 2B had improved ($P<0.05$) F/G compared to pigs fed diets containing Probios and BioSaf. These results indicate that whole diet irradiation or adding the feed additives to the irradiated diet did not improve growth performance. Eliminating the bacteria in the control diet by irradiation did not allow the impact of antimicrobial alternatives to be more easily measured.

(Key Words: Nursery Pig, Irradiation, Feed Additive)

## Introduction

Studies evaluating pigs fed diets containing supplemental yeast, direct-fed microbials, and mannanoligosaccharides have had mixed results. Due to the mode of actions of yeast, direct-fed microbials, and mannanoligosaccharides on bacteria flora, we speculate that the total bacteria concentration and makeup of the feed might affect antimicrobial alternative performance. Currently, commercially available feed additives have not been evaluated in diets with reduced bacterial content. It has been shown that the process of irradiation is effective in reducing the bacteria content of whole diets. In past KSU Swine Day Reports, DeRouchey et al. (2001, 2002) reported irradiation of spray dried blood products im-

[1]Food Animal Health and Management Center.

proves (P<0.05) growth performance in nursery pigs; however, irradiation of the whole diet did not enhance performance. Therefore, evaluating antimicrobial alternatives in irradiated or bacteria reduced diets may provide a model to test their efficacy and could define uncertainties with the use of antimicrobial alternatives.

## Procedures

A total of 360 weanling pigs (13.2 lb and 17 ± 2 d of age, PIC) was blocked by weight and allotted to one of nine dietary treatments. There were five pigs per pen and eight pens per treatment. Pigs were housed at the Kansas State University Segregated Early Weaning Facility. Each pen was 4 × 4 ft and contained one self-feeder and one nipple waterer to provide ad libitum access to feed and water.

All pigs were fed experimental diets immediately following weaning to d 27. There were nine experimental diets with a control diet with no antimicrobials, irradiated control diet with no antimicrobials, and the irradiated control diet with added; carbadox (50 g/ton), Probios® (1.6% from d 0 to 14 and 0.8% from d 14 to 21), BioSaf® (0.3%), Biomate Yeast Plus® (0.1%), Bio-Mos™ (0.3%), Bio-Plus® 2B (0.05%), or LactoSacc® (0.2%). BioSaf®, Biomate Yeast Plus®, and Lacto Sacc® are all concentrated forms of selected live yeast cells while Bio-Mos™ is a mannanoligosaccharide derived from yeast. Probios® is a form of lactic acid bacteria and Bio Plus® 2B contains two bacillus strains. All antimicrobials were added after the basal diet was irradiated. Diets were fed in meal form. Phase one diets (d 0 to 14) were formulated to contain 1.50% lysine, 0.90% Ca, and 0.54% available phosphorus. Phase two diets (d 14 to 27) were formulated to contain 1.45% lysine, 0.85% Ca, and 0.44% available phosphorus. In addition, diets did not contain growth-promoting levels of copper or zinc. All products were added at the manufacturers recommended inclusion rate. Samples of all diets were analyzed for bacteria concentration, and total plate count and coliform count were determined by diagnostic bacteriology testing (Table 2). Average daily gain (ADG), average daily feed intake (ADFI), and feed efficiency (F/G) were determined by weighing pigs and measuring feed disappearance on d 7, 14, 21, and 27 post-weaning.

Data were analyzed as a randomized complete block design with pen as the experimental unit. Pigs were blocked based on weaning weight, and analysis of variance was performed using the Mixed procedure of SAS.

## Results and Discussion

Irradiation was effective in reduction of the total plate and coliform count in the control diet (Table 2). From d 0 to 14 when pigs were fed phase one diets, treatment did not influence ADG and ADFI. Pigs fed the diet containing Bio Plus 2B tended to have improved (P<0.13) F/G compared to pigs fed diets containing carbadox or Probios. Pigs fed the diet containing Probios had a tendency for poorer (P<0.13) efficiency compared to pigs fed the control and irradiated control diet, and diets containing BioSaf, or Bio Plus 2B.

From d 14 to 27, there was no difference in growth parameters with the use of irradiation or the addition of feed additives.

Overall, (d 0 to 27) pigs fed the diet containing Probios had poorer (P<0.05) F/G compared to all other test diets except BioSaf. Furthermore, pigs fed either the non-irradiated and irradiated control diets or Bio Plus 2B had improved (P<0.05) F/G compared to pigs fed Probios and BioSaf.

Irradiation of the whole diet before adding antimicrobial alternatives was effective in reducing the bacteria concentrations of the diet. However, bacterial reduction by irradiation of the whole diet did not improve nursery pig

performance. When feeding irradiated diets, carbadox and antimicrobial alternatives did not improve growth performance in nursery pigs. Therefore, we speculate the bacterial concentration normally present in nursery diets is not a major factor when measuring the growth response of antimicrobial alternatives.

**Table 1. Diet Composition (As-fed Basis)**

| Item, % | Phase l[a] | Phase ll[b] |
|---|---|---|
| Corn | 49.11 | 52.61 |
| Soybean meal, 46.5% CP | 25.74 | 33.36 |
| Spray dried whey | 15.00 | 7.50 |
| Spray-dried animal plasma | 5.00 | - |
| Select menhaden fishmeal | - | 2.50 |
| Monocalcium phosphate, 21% P | 1.40 | 1.15 |
| Limestone | 1.10 | 0.85 |
| Salt | 0.40 | 0.40 |
| Vitamin premix | 0.25 | 0.25 |
| Trace mineral premix | 0.15 | 0.15 |
| Lysine HCl | 0.15 | 0.15 |
| DL-Methionine | 0.10 | 0.08 |
| Cornstarch or test ingredient | 1.60 | 1.00 |
| Total | 100.00 | 100.00 |
| | | |
| Calculated Analysis | | |
| Lysine, % | 1.50 | 1.45 |
| Isoleucine:lysine ratio, % | 60 | 66 |
| Leucine:lysine ratio, % | 131 | 134 |
| Methionine:lysine ratio, % | 28 | 31 |
| Met & Cys:lysine ratio, % | 58 | 57 |
| Threonine:lysine ratio, % | 64 | 61 |
| Tryptophan:lysine ratio, % | 19 | 19 |
| Valine:lysine ratio, % | 74 | 75 |
| ME, kcal/lb | 1,491 | 1,493 |
| CP, % | 21.90 | 22.50 |
| Ca, % | 0.90 | 0.85 |
| P, % | 0.80 | 0.75 |
| Available P, % | 0.54 | 0.44 |
| Lysine:calorie ratio, g/mcal | 4.56 | 4.41 |

[a]Diets fed from d 0 to 14.
[b]Diets fed from d 14 to 27.
[c]Test ingredients replaced cornstarch from the control diet.

**Table 2. Whole Diet Bacterial Count[a]**

| Phase One Diet, cfu/g | Total Plate Count | Coliform Count |
|---|---|---|
| Control / Non Irradiated | 38,700 | 2,550 |
| Control/ Irradiated | 350 | 15 |
| Carbadox | 330 | 30 |
| Probios | 855,000 | 5 |
| BioSaf | 5,102,177 | 0 |
| Yeast Plus | 1,375,125 | 0 |
| Bio-Mos | 4,720 | 0 |
| Bio-Plus 2B | 575,000 | 0 |
| Lacto Sacc | 3,450 | 0 |

| Phase Two Diet, cfu/g | Total Plate Count | Coliform Count |
|---|---|---|
| Control / Non Irradiated | 3,000 | 490 |
| Control/ Irradiated | 40 | 0 |
| Carbadox | 480 | 0 |
| Probios | 330,000 | 0 |
| BioSaf | 70 | 0 |
| Yeast Plus | 3,865 | 2835 |
| Bio-Mos | 50 | 0 |
| Bio-Plus 2B | 800,000 | 0 |
| Lacto Sacc | 16,350 | 0 |

[a]Values represent the mean of two different samples analyzed.

**Table 3. Effects of Irradiation and Antimicrobial Alternatives on Nursery Pig Performance[a]**

| | | Irradiated | Feed Additives[b] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Item | Control | Control | Carbadox | Probios | BioSaf | Yeast Plus | Bio-Mos | Bio-Plus 2B | LactoSacc | SE | TRT[c] |
| D 0 to 14[d] | | | | | | | | | | | |
| ADG, lb | 0.38 | 0.38 | 0.39 | 0.36 | 0.35 | 0.37 | 0.39 | 0.39 | 0.35 | 0.037 | 0.901 |
| ADFI, lb | 0.47 | 0.47 | 0.52 | 0.49 | 0.44 | 0.47 | 0.49 | 0.47 | 0.45 | 0.041 | 0.716 |
| F/G | 1.24$^{xy}$ | 1.24$^{xy}$ | 1.35$^{yz}$ | 1.40$^{z}$ | 1.27$^{xy}$ | 1.30$^{xyz}$ | 1.31$^{xyz}$ | 1.21$^{x}$ | 1.29$^{xyz}$ | 0.060 | 0.064 |
| D 14 to 27[e] | | | | | | | | | | | |
| ADG, lb | 0.95 | 0.97 | 0.96 | 0.94 | 0.80 | 0.91 | 0.98 | 0.93 | 0.93 | 0.061 | 0.203 |
| ADFI, lb | 1.24 | 1.25 | 1.26 | 1.33 | 1.10 | 1.21 | 1.28 | 1.21 | 1.23 | 0.075 | 0.216 |
| F/G | 1.32 | 1.29 | 1.31 | 1.40 | 1.39 | 1.32 | 1.31 | 1.31 | 1.33 | 0.046 | 0.204 |
| D 0 to 27 | | | | | | | | | | | |
| ADG, lb | 0.65 | 0.66 | 0.66 | 0.64 | 0.56 | 0.63 | 0.67 | 0.65 | 0.63 | 0.042 | 0.315 |
| ADFI, lb | 0.84 | 0.85 | 0.87 | 0.90 | 0.75 | 0.82 | 0.87 | 0.83 | 0.83 | 0.053 | 0.334 |
| F/G | 1.29$^{f}$ | 1.27$^{f}$ | 1.31$^{fg}$ | 1.40$^{h}$ | 1.35$^{gh}$ | 1.31$^{fg}$ | 1.30$^{fg}$ | 1.27$^{f}$ | 1.32$^{fg}$ | 0.037 | 0.003 |

[a]A total of 360 pigs initially 13.2 lb and 17 ± 2 d of age with five pigs per pen and eight replications per treatment.

[b]Inclusion rates are as follows; carbadox (50 g/ton), Probios® (1.6% from d 0 to 14 and 0.8% from d 14 to 21), BioSaf® (0.3%), Biomate Yeast Plus® (0.1%), Bio-Mos™ (0.3%), Bio-Plus® 2B (0.05%), or LactoSacc® (0.2%).0 to 14 fed phase one diet formulated to contain 1.50% lysine, 0.90% Ca, and 0.54% available P.

[c]P-value represents overall treatment effect.

[d]Inclusion rates are as follows; carbadox (50 g/ton), Probios® (1.6% from d 0 to 14 and 0.8% from d 14 to 21), BioSaf® (0.3%), Biomate Yeast Plus® (0.1%), Bio-Mos™(0.3%), Bio-Plus® 2B (0.05%), or LactoSacc® (0.2%).

[e]14 to 27 fed phase two diet formulated to contain 1.45% lysine, 0.85% Ca, and 0.44% available P.

[fgh]Means in the same row with different superscripts differ (P<0.05).

[xyz]Means in the same row with different superscripts differ (P<0.10).